The Sclerotinia Rot of Celery

GETTING AN UP-TO-DATE GREENHOUSE IS THE FIRST STEP TOWARD THE CONTROL OF CELERY ROT

NEW JERSEY
AGRICULTURAL EXPERIMENT STATIONS

NEW BRUNSWICK, N. J.,
January, 1922

NEW JERSEY AGRICULTURAL EXPERIMENT STATIONS*

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THE SCLEROTINIA ROT OF CELERY[1]

NEW JERSEY
AGRICULTURAL EXPERIMENT STATIONS
BULLETIN 359

January 1, 1922

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Assistant Plant Pathologist

Introduction

A "damping-off" disease affecting all varieties of celery plants grown in the greenhouses in the muck bog areas of Bergen County, has been very destructive for a number of years. The disease has been severe also in greenhouses elsewhere and has attacked plants growing on other soil types in the state. The damping off is due to a fungus known as *Sclerotinia libertiana* (Fuckel). The disease has been the subject of much inquiry on the part of celery growers. It has been reported a number of times after it had destroyed nearly all of the plants in greenhouses, and at other times when there was a small amount of infection.

Celery seed is sown the latter part of February and the plants are forced in order that they will be large enough to set in the fields in April. The young plants are liable to be attacked at any time after the seeds germinate. The most frequent and the heaviest losses occur about the time the plants are large enough to set in the field. The disease sometimes destroys 95 per cent of the plants in a greenhouse in a few days.

Although the disease has been most destructive to celery in the seed-beds, it has not caused severe losses in the fields. Sometimes a small loss occurs after the celery is placed in boards for blanching. Proper sanitary measures have not been practiced in most of the bog areas and the fungus is gradually spreading over the cultivated areas. In this paper the writer has presented the results of his investigation of the *S. libertiana* rot of celery since 1917.

1 Opportunity is taken here to express the writer's indebtedness to Dr. Mel. T. Cook, Plant Pathologist, for helpful advice in carrying out the work on this problem.

There are several other root rots of celery that occur in the muck areas. Some of them are very destructive, both in the greenhouse and in the field. A bacterial rot of Golden Self-Blanching celery is very severe in some sections. It occurs in the greenhouse, but is most destructive in the field. The so-called "green varieties" are practically resistant to this bacterial rot under field conditions. *Rhizoctonia* and other rots have caused small losses at times.

FIG. 1. THE DISEASE ON SMALL SEEDLINGS IN A GREENHOUSE BED

Note that the green topped plants also have fallen to one side in some cases. Small plants die very suddenly and dry up after they are attacked by **Sclerotinia libertiana.**

Literature

A great many workers have been interested in the organism, *S. libertiana* (Fuckel). Beach (1), Berger (2,3), Jagger (4), Sherbakoff (5), Smith (6), Stevens (7), Stevens and Hall (8), Stone and Smith (9), Wolf and Cromwell (10), and others have studied the organism. Some have made studies of both its parasitism on lettuce and of the methods of control. Jagger (4) has recently reported *Sclerotinia minor* as occurring with *S. libertiana* and of equal parasitism on lettuce, celery and other plants in Massachusetts, Pennsylvania, New York and Florida. Beach (1) has also published an account of this fungus in Pennsylvania.

The writer has observed small sclerotia [2] on lettuce in this state, which were probably of *S. minor.* Wolf and Cromwell

[2] Sclerotia are those parts of the fungus which serve to carry it over the winter, or resting period.

(9) have compared and distinguished *S. libertiana* and *Sclerotinia trifoliorum*. They found that these two species will cause decay of both lettuce and clovers. They showed that the two species can be distinguished by the growth of mycelium and the size of asci and spores. Burger (2, 3) advised growers against planting lettuce and celery alternately on land severely infected by *S. libertiana*.

Others have reported the disease on celery in the field, in storage and in transportation. Sherbakoff (5) said, "the im-

FIG. 2. A ONCE CROWDED SEED-BED

The white vegetative mycelium of the fungus appears in beds where plants are densely crowded. After the plants fall over, the cottony mycelium becomes very prominent on the leaves and on the top surface of the soil.

portance of damping-off can be well illustrated by the experience of some otherwise most successful truckers of Terra Ceia Island. To have enough plants for two acres of celery they had to maintain a whole acre or more of seed-beds, because the beds were affected by damping-off. This handicap alone was sufficient to force them to abandon celery culture." He considered the trouble as being due to *S. libertiana* and to *Rhizoctonia*.

Distribution of the Disease

The disease is very common in New Jersey, and has been found on several types of soil. Where lettuce has been con-

stantly grown for a number of years the soil is usually infected with *S. libertiana.* The disease in the past few years has manifested itself very noticeably in the greenhouses (fig. 1) of the bog areas of Bergen county, where a great many houses showed some signs of being infected during the months of February to May. The organic muck soil when used in the beds, appears to be especially favorable for the development of this fungus at the time the plants become infected. The "foot rot" symptom is sometimes observed on celery after it is placed in boards or banked for blanching. Shaded and crowded plants sometimes become infected to a small degree in the field.

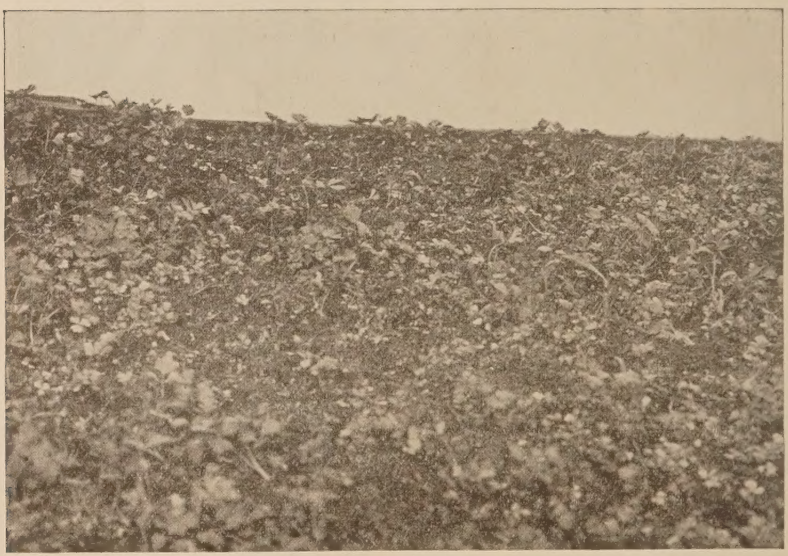

FIG. 3. A BED OF SEEDLINGS SALVAGED BY DRYING

Some time after the disease had killed out a very large number of the plants, this bed was permitted to dry out. The unattacked plants continued to grow, while the diseased plants dried up. The organism is retarded by dessication. Drying out the houses will readily destroy the white fungus growth and decrease infection.

Other Plants Attacked by the Organism

The fungus causes rots of clovers, grasses, and a large number of vegetable and truck plants. The writer has observed the organism on pepper, spinach, rhubarb, lettuce, celery, carrots, cabbage, cauliflower, cucumber, bean, eggplant, parsley, rye, and burr clover. It causes a large variety of plants to damp-off in the seed-beds. It is known as "drop" on lettuce, "pink rot" and

FIG. 4. TWO 3-POUND STALKS ATTACKED BY *Sclerotinia*

These stalks were between boards for blanching. The sclerotia, or resting bodies of the organism, can be seen on the stalks and at the right. This is also characteristic of the rot in storage. There was a watery, pinkish tinge to the plants. The cottony white mycelium was abundant, but dried after the sclerotia formed.

FIG. 5. A TYPICAL CASE OF CELERY ROT

Sclerotinia libertiana attacks the plants just above the soil and causes them to rot very quickly. On these plants there was a watery rot, but the white mycelium had not developed. (See fig. 6.)

FIG. 6. GROWTH UNDER OPTIMUM CONDITIONS

The same plants as those in figure 5 after 24 hours' incubation at 30 C. Note the cottony white mycelium of the fungus on the plants. The sclerotia have begun to form.

"watery soft rot" of celery, and "blight" of beans. There is no doubt that a great many other plants are susceptible to this fungus under favorable conditions for infection.

Description of Sclerotinia Rot

In greenhouse beds during the spring when moisture and temperature conditions fluctuate a great deal, *S. libertiana* attacks the young celery plants just above the surface of the soil causing a destructive, watery, soft rot of the stem. The plants fall over and a white, cottony mass of the vegetative fungus generally develops on the green leaves and the stems. The mycelium infects the surrounding seedling plants, causing them to damp off and the leaves to rot. Sometimes the mycelium is very prominent in beds where plants are dense and large, destroying the tops and other parts after they fall to the ground. Small, black sclerotia (fig. 4, 7) are formed by the white fungus mycelium a few days after the plants damp off. They are the resting stage of the fungus and should be destroyed before they mature and fall into the soil. These black sclerotia remain in the muck soil beds until the next spring, where they produce apothecia [3] under favorable conditions. The sclerotia formed on greenhouse plants are usually very small as compared with those formed on the large celery stalks in the field. The period of fungus growth is short on small celery plants and the time is not sufficient for larger sclerotia to form. Small plants are damped off very quickly. In most cases the plants maintain their green color until the stems rot off, but sometimes the plants turn yellow after becoming infected (fig. 1, 2, 3, 5).

The fungus causes a watery soft rot of celery in the field and in storage (fig. 4). The white mycelium develops quickly and abundantly on the decaying plants (fig. 6). Large numbers of sclerotia develop on the decaying surface. The sclerotia are at first the same color as the white mycelium and soft, later they become black and hard. These bodies are very characteristic of the fungus, and they are usually formed a few days after the mycelium has made a good growth on the plant.

Lettuce drop is caused by the same fungus (fig. 9, 10). The mycelium and the sclerotia are even more prominent on lettuce than on any other host. A sudden wilt of the lettuce plant is a good indication of the disease. The mycelium infects the plants and sclerotia develop very largely on leaves next to the ground. The plant is rarely attacked in the top and the roots of the plant are not usually attacked by this fungus. The fungus growth may develop to such an extent that the tops and roots will be

[3] Apothecia are those parts of the fungus which bear fruit, or spores.

completely destroyed. The rot has no disagreeable odor but other organisms following the parasite on the plant do produce odors that are sometimes offensive.

The Life History of Sclerotinia Libertiana

The life cycle of *Sclerotinia libertiana* is not difficult to solve. During the growing season the organism generally ap-

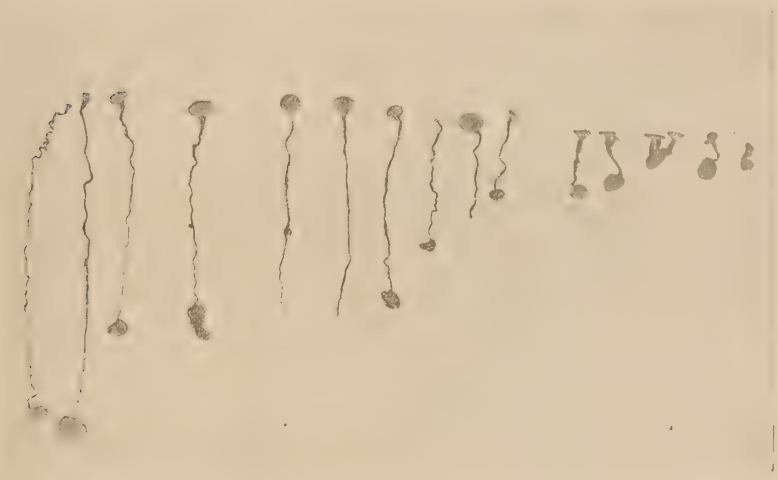

FIG. 7. HOW THE DISEASE IS CARRIED OVER WINTER

The small black bodies (sclerotia) at the lower ends of the fungus parts shown, rest in the soil generally, during the winter, for periods of a month to a year or longer after they mature. They then produce the disc-like apothecia, always above soil, sometimes from a depth as great as three inches or more. These apothecia carry numerous asci, or spore cases (fig. 8). Under favorable conditions the individual spores germinate (fig. 8) infect the soil, and the mycelium attacks the plants.

pears throughout the bogs on lettuce. The white mycelium produces numerous black sclerotia on lettuce and celery. The sclerotia are usually produced in large numbers on the lower leaves of infected lettuce heads, where favorable temperature and moisture conditions are maintained under the plant. They harden and fall to the ground, where they are disseminated by farm implements to all parts of the field, and under field conditions, may fail to produce apothecia for several years, especially when they are plowed deep into the soil. The sclerotia produced one summer may develop apothecia in the fall or during the summer, but usually the following spring and summer. Apothecia are produced from the sclerotia in the greenhouses

from February to June. They extend ¼ to ½ inch above the soil and rise from three or more inches deep (fig. 7). In the apothecia are found the spore sacks, or asci, each of which contains eight spores. Each apothecium produces several thousand spores. Under favorable moisture and temperature conditions the spores are discharged from the top of the asci and are disseminated in the soil, at a time when the plants are very susceptible to infection. The spores germinate in the soil, where the mycelium lives saprophytically (upon dead organic matter) until it attacks the green plants (fig. 8). The amount of this white, cottony mass of fungus growth and the number of black sclerotia produced depend very largely on the nutrition of the soil medium, the density of the plants, and the temperature and moisture conditions in the houses and in the field. Burger (2, 3) said, "In Florida under favorable field conditions, sclerotia may form apothecia in about thirty days." This may be true under New Jersey conditions. The writer has observed the formation of apothecia in the muck soils as late as June. The sclerotia are usually formed in the spring on the small plants in the greenhouses. They remain dormant in the soil until the following spring. The growers close down their greenhouses and allow the soil to dry out from March to February of the following year. The sclerotia produce apothecia in the greenhouse beds from February to May, causing reinfection. New sclerotia are formed which continue to perpetuate the disease from one year to another.

Source of Infection

In 1917 damping-off of celery plants was severe in several greenhouses in Bergen County. The plants were about two inches high, very thick and green. The Golden Self-Blanching and the so-called green varieties were both found to be severely infected with *S. libertiana*. The weather was cloudy and damp, but warm for several days preceding the heavy losses. A great many fruiting apothecia of the fungus were found in the greenhouse beds of celery at this time. The most interesting thing learned about the disease was the depth from which the stype pushed from the soil so that the apothecia could form above the soil surface. The stype is the part of the fungus that acts as a small stalk between the apothecia and the black sclerotia. The length of this stalk was found to vary considerably (fig. 7). When the sclerotia were near the surface of the soil the stypes were very short but when deep, the stypes were sometimes as much as 3 inches in length. It seems possible that the sclerotia may be able to develop from a greater depth. The apothecia

were usually small when the sclerotia were very deep. However, this was not always a characteristic of those which developed from a depth of ½ to 1½ inches.

The fungus usually made its appearance in the greenhouse in spots finally spreading out in circles over the entire bed. The apothecia were usually numerous at the center of infection. This seems to show that infection follows the development of

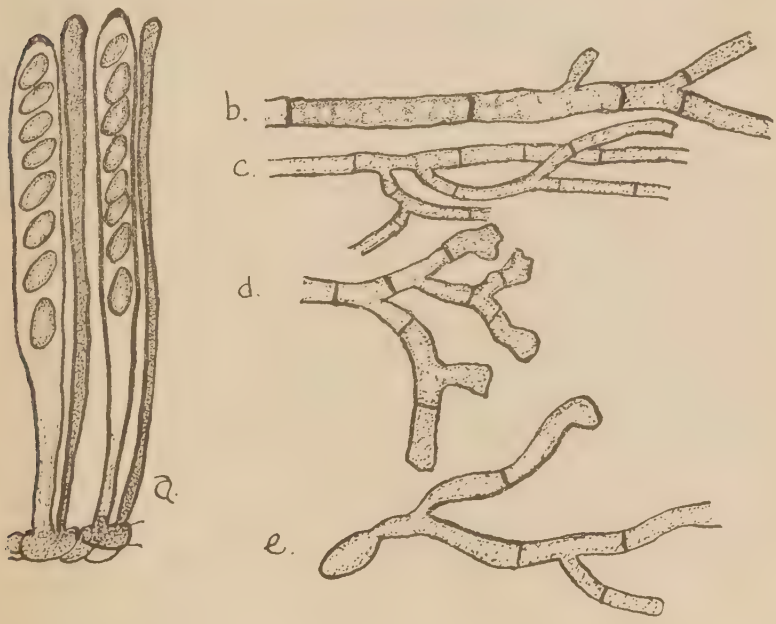

FIG. 8. VARIOUS STAGES OF THE FUNGUS

(a) Asci containing spores. (b) Cottony mycelium. (c) Branching of mycelium. (d) Sclerotia forming from mycelium. (e) A spore germinating and producing the cottony mycelium which attacks the plant.

the apothecia, the liberation and germination of spores of the fungus. Infection was prevalent in the shaded moist places of the houses. After remaining dry in the greenhouse soil, over the summer and winter the apothecia develop from the sclerotia at various periods from February to May. In February the seed are sown and water applied. Sometimes with forcing temperature and moisture conditions the apothecia are produced in the

same time required for germinating the celery seed. In an infected house, apothecia were continually collected from March to June. They continue to germinate at various periods during the spring under favorable moisture and temperature conditions. Under greenhouse culture of celery plants, the sclerotia produced during one season form apothecia the following spring.

FIG. 9. THE *Sclerotinia* ROT OF LETTUCE ON MUCK SOILS

A great many sclerotial bodies, which carry the disease over from one season to the next are produced on the bottom leaves of these plants and drop into the soil.

The soil in the infected greenhouse beds was taken from a field on which lettuce previously had been grown. According to the grower there was a good deal of "drop" in the lettuce field from which the soil was secured. During the past few years soils taken from infected fields, especially where there was a good deal of lettuce "drop," have always proved to be a great source of infection. Growers who have not grown lettuce in rotation with celery have had less trouble with damping-off. In a few instances in the bogs, the disease has spread from one field to another apparently by wind-blown spores, and the dessemination of sclerotia by flood waters. This is known to be the source of infection in one greenhouse. The owner has not grown lettuce on his place to the writer's knowledge, but it is grown extensively on adjacent areas. The diseased lettuce

plants are sometimes raked out and piled along ditches near his field. The organism has persisted in his houses for several years, and the infection may have started from a few sclerotia. In all cases observed in the greenhouse, infection and decay of plants did not exist until the apothecia were observed. This substantiates Stevens and Hall (8), who say, "The ascospores are comparatively short-lived, even under the conditions most favorable to their longevity. The mycelium has also been shown

FIG. 10. A BAD PRACTICE

A very large number of diseased lettuce heads are plowed under after the crop is cut. Many sclerotia formed on the decaying heads also are plowed under from one to six inches.

to be of comparatively short life and to retain its infecting power but a short time in the absence of nutriment. The sclerotium is long-lived and well adapted to perpetuate the fungus." These authors have shown that the ascospores do not cause direct infection. The writer has observed infection of bean pods 12 inches above the ground while the roots were not affected (fig. 12). This may indicate that the ascospores do cause direct infection in some cases.

In 1917 and 1921 plants were set in fields from the severely infected beds. In both years less than 1 per cent of the plants

set have died from this disease. This is probably due to the fact that the mycelium dried out under field conditions before it could regain vitality to attack the host. In this experiment all plants which showed any sign of rot were thrown out. Only the best plants were taken from the beds for planting.

Losses Due To Sclerotinia Rot

In other states the rot has been reported severe in the field, and Burger (2) writes, "Do not follow a crop of lettuce with celery, or celery with lettuce, as both crops are subject to this disease."

TABLE I

*Celery Losses During Shipment Due to Libertiana**

1919			1920		
Origin of Shipment	No. of Cars	Decay	Origin of Shipment	No. of Cars	Decay
California	5	2 cars 80% 3 cars 50%	California	14	1 car 25-30%
Colorado	1	1 car 100%			
Florida	9	1 car 50% 4 cars 20% 3 cars 5%	Florida	36	1 car 50% 1 car 75%
Illinois	1	*	Louisiana	1	*
Michigan	4	2 cars 100% 2 cars 10-20%	Michigan	8	*
New York	4	2 cars 100%	New York	11	11 cars 25-75%

* All cars showed from a trace to severe infection. Infection is generally most severe in the upper tiers.

Sherbakoff (5) observed severe losses on Terra Ceia Island. He said, "To have enough plants for two acres of celery they had to maintain a whole acre or more of seed-beds, because the beds were affected by damping-off. This handicap alone was sufficient to force them to abandon celery culture which otherwise has been one of the most profitable lines of trucking in that place." The disease is severe and causes heavy losses elsewhere, as shown by percentages of "water soft rot" reported June, 1919 and 1920 by the Bureau of Markets (11, 12) in cars of celery after they had reached their destination, (table 1).

Control Measures

Sanitation

While most interest lies in controlling the disease in greenhouses in the bog areas at the present time, some attention must

be given to the disease in the field, for soil for the greenhouse beds is taken from the cultivated fields. The dissemination of the organism in the bog areas is largely due to the practice of growing lettuce and celery in rotation. The disease is readily disseminated where lettuce is cropped. When the entire area of bog soils becomes infected, it will be very difficult to secure virgin soil for the greenhouse beds. Sanitary measures to prevent further infection of field areas are to be encouraged. All diseased plants should be destroyed. Tools such as hoes, and rakes used in the field should be cleaned before working the greenhouse beds.

Replacing Soils

It is a policy of some growers to continue cropping celery in the same muck soil in greenhouse beds for a number of years. Others change the soils nearly every year. It is more satisfactory to use the same soil for several years or as long as the soils do not become infected with organisms which cause this and other celery diseases.

Experiments have shown that horse manure, when it is obtained from a reliable source can be applied to the muck soils in the beds each year without introducing disease-producing organisms. Manure is necessary for obtaining best results on muck soils. Bacteria and molds in manure appear to produce substances which break down some of the organic matter of the muck soils into available plant-food. The manure also tends to balance the necessary plant-food elements.

When old soil becomes infected, it should be replaced with soil from fields where lettuce has never been grown, and as far as possible from fields where infection has never been observed. This procedure was followed in several greenhouses with good results in controlling *S. libertiana.* Before putting the new soils into the beds, all old soil was removed and the beds washed clean, and sterilized with a formaldehyde solution.

Experiments were carried on in a severely infected greenhouse in 1917 to determine if the disease could be checked in the greenhouse beds. Infected areas were divided into sections; Pyrox, Bordeaux mixture, lime-sulfur, and nitrate of soda were applied to the soil of the various plots. Bordeaux mixture checked the disease to a slight degree when the plants and topsoil layers were saturated. In the plots treated with nitrate of soda, the plants which had not died because of the fungus, were stimulated, but very little control was observed.

Rogueing

Rogueing has checked the disease in greenhouse beds where the plants are very thick by thinning out the plants and also by removing small infected areas in the beds. The practice of spotting plants decreases the danger of infection very much, especially while the plants are small. Infection sometimes becomes very severe on spotted plants after they reach 3 or 4 inches in height. At this size the stem and lower leaves are shaded, producing a favorable condition for infection. Severe cases of infection usually occur in thickly sown beds, where the stems of the plants are shaded from the time they germinate until they are set in the field. It has been shown in practice that it is advisable to thin the plants in the beds where they are thick and crowded. In nearly every instance where the beds were infected, the decay of the plant was stimulated when the tops were clipped off, and allowed to fall down between the plants. The clipped tops should not be allowed to remain in the beds to decay, as they are frequently the source of other rots.

Diseased plants should be removed from the field and destroyed before the black sclerotia mature on the plant and fall to the ground. If the fruiting bodies of the fungus are plowed under, they may remain active for several years and continue to perpetuate the disease in spite of the very best methods of sanitary practice that the farmer might follow.

Soil Treatment

On a number of farms, steam sterilization has proven very effective in controlling *S. libertiana,* especially in the greenhouse beds. Where lettuce is grown extensively during the fall and early spring under sash, steam sterilization not only controlled the damping-off organisms, but destroyed the various grass and weed seeds. This cuts down the expense of weeding. Stone and Smith (9) reduced the *S. libertiana* rot in greenhouse beds only 5 per cent with steam. They got much better results with hot water. They say, "The treatment of the soil by hot water which raised the temperature of the surface from 176°F. to 186°F. to a depth of 4 inches, reduced the amount of drop 76 per cent and completely killed the Rhizoctonia." Steam sterilization is far from practical among the celery growers, as their farms are usually small. The formaldehyde method of control is economical and very effective where farming is done on a small scale.

Formaldehyde has been experimented with in greenhouses on several farms. In 1917 very striking control results were obtained by treating an infected greenhouse bed of muck soil with 3 pints of formalin to 50 gallons of water applied at the

rate of 1 gallon to the square foot of soil. The soil was 8 to 10 inches deep in the beds. Enough water was applied to moisten the entire soil depth before applying the treatment. In this experiment, the disease caused the loss of nearly all plants in the checks, while a complete control was produced in the treated plots.

(a) (b)

FIG. 11. EFFECT OF STERILIZATION

(a) Soil in these three pots was sterilized with formaldehyde. 3 pints to 50 gallons of water at the rate of 1 gallon of solution per square foot of soil.

(b) Three pots to which 3 pints to 25 gallons of water were applied at the rate of two quarts solution per square foot soil. The amount of water applied was not sufficient to saturate the soil and distribute the formaldehyde, for the pots indicate that **S. libertiana** was not destroyed.

In the spring of 1921, W. Raymond Stone, county agent of Bergen county, and the writer treated a greenhouse bed on the farm of T. H. Winters. His house, which is one of the best in the bog section, is well equipped for heating, contains electric lights and concrete beds and is modern in nearly every respect (fig. 15). The system of ventilation only could be improved. The concrete beds are about 2 feet high. The first 12 inches of the bed is sand, and the remainder is filled with muck soil.

The soil in his greenhouse was known to be infected last

year. One of the beds was divided into six areas, of 50 square feet each. The soil was slightly moistened. Applications of formalin varying in strength from 3 to 6 pints mixed in 25 gallons of water, and also in 50 gallons of water were made. The object of the experiment was to determine the strength of formaldehyde necessary to control the disease, and also to determine whether it is necessary to saturate the soil when the applications of various strength are made.

The results were very interesting. They showed (table 2) that 3, 4 and 5 pints of formaldehyde controlled the organism when applied in 50 gallons of water to 50 square feet of bed. The same strength used in 25 gallons of water applied to 50 square feet of bed gave only slightly better control than the checks.

TABLE II

Effect of Formalin Treatments of Varying Strength in Controlling Sclerotinia Libertiana in a Greenhouse Seed-Bed

Plot	Formalin	Water	Control
	Pints	Gallons	
1	3	25	poor
2	4	25	poor
3	6	25	poor
4	3	50	complete
5	4	50	complete
6	6	50	complete
7	0	50	poor

As a result of the experiments in the greenhouses of the muck soil areas of Bergen county, it is recommended that where infection occurs, fresh soil selected from areas some distance from where lettuce has been grown should replace infected soils in the greenhouse beds, after they have been thoroughly cleaned. The first season, the fresh soil should be sterilized with formaldehyde, 3 pints to 50 gallons of water, applied at the rate of 1 gallon per square foot, 7 to 14 days before sowing the seed. The solution may be applied with a sprinkling can. The soil should then be covered with burlap bags for two or three days following treatment. It is also advisable to work the soil thoroughly to permit airing several days before sowing the seed. Special care should be taken to prevent re-infection. **Plows, hoes and other tools used in the field should be kept from the greenhouses,** unless they are thoroughly sterilized.

Soil moisture and temperature conditions should be regulated carefully during periods of damp and cloudy weather. The growers must exercise good judgment in this regard, as no one can follow a set rule. The grower who studies his own

greenhouse conditions and acts on his observations will generally be most successful when temperature and moisture conditions are concerned. Greenhouses constructed so as to receive a large amount of sunlight and ventilation have not harbored *S. libertiana* to the extent that it has been found in the shaded and poorly ventilated houses.

It is important to remember that if the disease was present in greenhouses this spring it will most likely cause a great deal of trouble again next spring. The fungus produced fruit bodies this spring which, with favorable moisture and temperature con-

FIG. 12. WHITE MYCELIUM AND BLACK SCLEROTIA ON BEANS

These pods were 12 inches and more above the ground, but the base of the stalk was not diseased. Some of the pods were not affected.

ditions, will germinate during the period of growing the sets from February to June next year. The beds must be cleaned thoroughly, so that all the black sclerotia are removed from the houses.

Nearly all soils where lettuce is grown are infected by this organism. Such soils should not be used in greenhouse beds. Get soil that is least likely to be infected. It is advisable to sterilize it with formaldehyde the first year, as a small amount of the organism which causes the disease will enlarge and spread over an entire greenhouse bed in a few days of damp and warm weather.

The heart rot, or root rot, of Golden Self-Blanching celery is caused by bacteria. It is very severe in the field on this particular variety. A publication to cover this disease is now in preparation.

Summary

1. *Sclerotinia libertiana* rot has been severe on all varieties of young celery plants in greenhouses in the muck bog areas of Bergen county during the time seedling plants are grown from February to June.

2. Celery is not severely attacked in the muck soil fields by *S. libertiana* in this state. It is reported as severe in Florida celery fields. Sometimes light losses do occur on all types of soil. Lettuce is severely attacked on both upland and on bog soils in many sections of the state.

FIG. 13. A NATURAL-SIZE PHOTOGRAPH OF BEAN PODS SHOWING FUNGUS GROWTH, AND LARGE BLACK SCLEROTIA

3. *Sclerotinia libertiana* has been studied by a great many workers on plant diseases. Several papers have been published in which *S. libertiana*, *S. trifoliorum* and *S. minor* have been distinguished as different species by morphological comparisons.

4. *Sclerotinia minor* has caused a similar rot of celery and lettuce in other states. It has not been observed in the bog soils of this state. It has been found on upland lettuce. Every effort should be made to keep this fungus from the bog soils.

5. The disease is commonly called "foot rot", "pink rot" and "water soft rot" of celery, lettuce "drop", and "blight" of beans.

6. *S. libertiana* is introduced into the greenhouse beds in soils taken from infected fields. No disease developed in virgin muck soils when used in greenhouse beds. It is recommended in case soils are used for several years without showing

any sign of being infected, that their use be continued, as the *S. libertiana* organism is liable to be brought into the house with new soils. If other diseases develop in the greenhouse beds the soil should be removed and replaced with new.

7. The disease causes most damage in poorly ventilated houses. Houses constructed so that a large amount of sunlight reaches all beds, and with sufficient ventilation to control the moisture and temperature conditions, will reduce the disease.

8. Infected lettuce and celery plants should be removed from the field and destroyed as soon as they are observed. This will decrease the number of sclerotia that usually develop when infected plants remain on the field for some time.

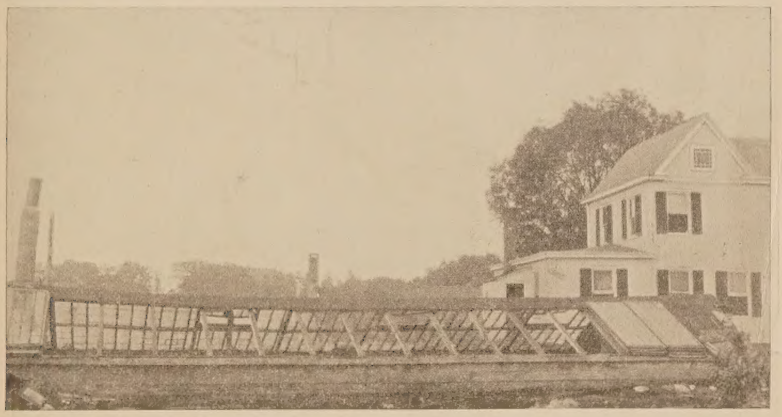

FIG. 14. A GREENHOUSE WHERE *Sclerotinia* ROT MAY BE VERY SEVERE

It is impossible to control the temperature in this type of house. Sunshine cannot reach the beds. The owner of this farm has recently built one of the best greenhouses in the bog area. The new house has concrete beds and an excellent heating system. By securing uninfected soil, he has controlled the Sclerotinia rot during the past few years.

9. Best control results have been obtained by replacing infected soils with virgin soils. Formaldehyde has proven valuable in giving control through the sterilization of the greenhouse beds. Infected muck soils treated with 3 pints of formalin to 50 gallons of water applied at the rate of 1 gallon to the square foot of soil controlled the disease in the greenhouse.

10. Plants which showed no signs of being diseased have been set from infected beds into the field with very little loss. While this method is practicable it might in some cases intro-